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Decreasing Check-In to Discharge Time in the PTC

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By

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Capstone Approval Page

Capstone Title (print or type)

Decreasing Check-In to Discharge Time in the PTC

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HONORS THESIS ABSTRACT

Guidelines

Your abstract should begin with a definitive statement of the problem of project. Its purpose, scope and limit should be clearly delineated. Then, as concisely as possible, describe research methods and design, major findings, including the significance of the work, if appropriate, and conclusions.

Students whose thesis involves “creative” work (original, fine art, music, writing, theatre or film production, dance, etc.) should describe process and production. Indicating the forms of documentation on file as “thesis” materials.

Please have your advisor review your abstract for organization, content, grammar and spelling before submission.

HONORS THESIS ABSTRACT
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ABSTRACT (100-200 WORDS):

The Physician Treatment Center (PTC) at Central DuPage Hospital, part of Northwestern Medicine, has seen a 21% increase in patients over the past year.
This increase caused severe strain on PTC staff and space. Before deciding to purchase more resources, according to best business practices, the project team was assembled to optimize process efficiency.
The purpose of this study is to reduce overworking and overcrowding in the PTC through accurate centralized scheduling and the reduction of patient in-room time. These together will lead to a reduction in the check-in to discharge time of the patient. These objectives were accomplished through the use of Six Sigma's DMAIC Cycle and Lean methodology.

DECREASING CHECK-IN TO DISCHARGE TIME IN THE PTC

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Northern Illinois University

Northwestern Medicine®

5/5/2017

Executive Summary

The Physician Treatment Center (PTC) at Central DuPage Hospital, part of Northwestern Medicine, has seen a 21% increase in patients over the past year. This increase caused severe strain on PTC staff and space. Before deciding to purchase more resources, according to best business practices, the project team was assembled to optimize process efficiency.

The project team utilized Six Sigma and Lean methodology, originally developed for manufacturing, to increase process efficiency in the field of healthcare. Patient in-room time was reduced through a two prong approach: (1) accurate centralized scheduling and (2) reduced non value-added process time. As a result of this study, patient satisfaction, PTC throughput, and room utilization increased. The staff is no longer strained for resources and it is equipped to handle a continued increase in patients.

The project team initiated the define phase of the project with the creation of a project charter, scope definition, current state map, and identifying the voice of the customer. The timeline objectives, timeline, scope and deliverables are clearly stated in the project charter. Next, the measure phase sought to quantify the current state of the process and identify areas for improvement. Thus, the following steps were conducted; a pareto chart to identify common infusion types, the establishment of baseline metrics, a time study was conducted to identify that the patients were experiencing large and frequent pharmacy delays, room utilization was graphed and found not to be a constraint, and a graph of patients in the PTC by hour verses room capacity revealed that patient scheduling is an issue. Next, root causes of these measured problems were identified in the analyze phase. Among the main issues were; no transportation available for finished medications, room 11 underutilized for fear of privacy violations, and patients scheduled in the morning because of decentralized scheduling and a fear of add-ons later in the day. The project team solved each root cause of a long check-in to discharge time through meetings in the improve phase; with updated standard work, regarding the implementation of a morning phone call between pharmacy and PTC staff, the establishment of a PTC medication runner as needed, scheduling accurate appointment times, a new procedure to push certain appointments to the afternoon, and centralized scheduling. Lastly, a control plan was developed, which PTC staff agreed to follow to ensure the sustained success of this project.

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1. Introduction

The Physician Treatment Center at Central DuPage Hospital was born out of the Emergency Department. It was conceived as an idea of how to keep patients from being admitted to the hospital through and emergency visit for non-emergency situations. It is a unique hospital department, and it offers a variety of services. The PTC offers medication infusions, blood transfusions, wound care, and a vast number of procedures.

The project team partnered with Northwestern Medicine's Performance Improvement Office at Central DuPage Hospital to tackle this project. The project team utilized Six Sigma's DMAIC methodology to approach this project. DMAIC is broken down into five phases: Define, Measure, Analyze, Improve, and Control. The structured problem-solving approach gives guidance to the project and how to proceed (iSixSigma, 2017).

2. Define

2.1 Problem Description

The PTC at Central DuPage Hospital has experienced a 21% increase in the amount of appointments January 2016 to January 2017. This increase in demand has only been met with a corresponding 7% increase in nursing staff levels. This means that the nurses and staff of the PTC are feeling overworked. The department had to previously expand business hours on select days in order to meet demand, and the leaders of the department even wanted to request that an additional full time nurse be hired to accommodate for this. However, the department was unable to hire an additional full time nurse unless it already proved to be as efficient as possible with the current staffing levels.

Space was also a concern for the PTC leadership. The PTC shares its rooms with the Bariatrics department for certain hours throughout the week. The scheduling staff felt that there were not enough rooms in the department to schedule patients in during the

peak appointment times of the day. The PTC schedules between 30 and 50 appointments per day, and there is also variability with add-ons. An add-on can come to the PTC from other departments in the hospital, or even throughout the network. A main source of add-ons is from the Warrenville Cancer Center. Due to the nature for the reason of the appointment, the add-on appointments come with extremely little notice.

Another motivator for this project is the completion of the system-wide orders project that Northwestern Medicine finished in December 2016. Prior to this project, patients were restricted to going to the same hospital or office that their physician was at in order to receive their medication infusion. However, the system-wide orders project opened up the entire Northwestern Medicine Network for availability for the patients to receive treatment at the location that is most convenient for them. This means that the PTC should see an influx of patients who had previously had to go downtown Chicago to receive their medication infusions. It is vital that the PTC be able to utilize their resources efficiently in order to handle the increase in patient appointments.

While defining the problem, the project team looked at the voice of the customer to gain insight of where to start on the project. The patients were saying that there were long delays in receiving their medications. The patient was simply sitting in the room for an extended period of time with nothing being done because the medication was not mixed for them yet. The scheduling staff also voiced their concerns about space in the PTC. The schedulers have little control over when patients are scheduled for the appointments. The current practice is that the patient tells the nurse when he or she wants to come in for their next appointment, and the nurse accepts. The scheduler would then have to try and squeeze the patient into an already busy schedule, or if they must, call the patient back to reschedule. The nursing staff also shared their concerns with being extremely overworked in the mornings, but then being sent home early in the afternoons due to a drop off of appointments.

2.2 Objectives

The project team decided that optimizing the PTC's scheduling procedures, reducing the check-in to discharge time, increasing room utilization, and increasing patient capacity will help to make the PTC more efficient. This is a common issue in healthcare, but the DMAIC methodology is not often applied as a solution, since it is most frequently associated with healthcare (Gupta & Denton, 2008). With these changes, there will be increased levels of satisfaction of both the patient and the PTC's nurses and staff. Long-term effects were also identified, and can be seen in Figure 1.

2.3 Scope and Deliverables

The project team narrowed the scope of the project to the 13 rooms of the PTC department and included communication between the PTC, pharmacy, blood bank, and the cancer center. The Bariatric

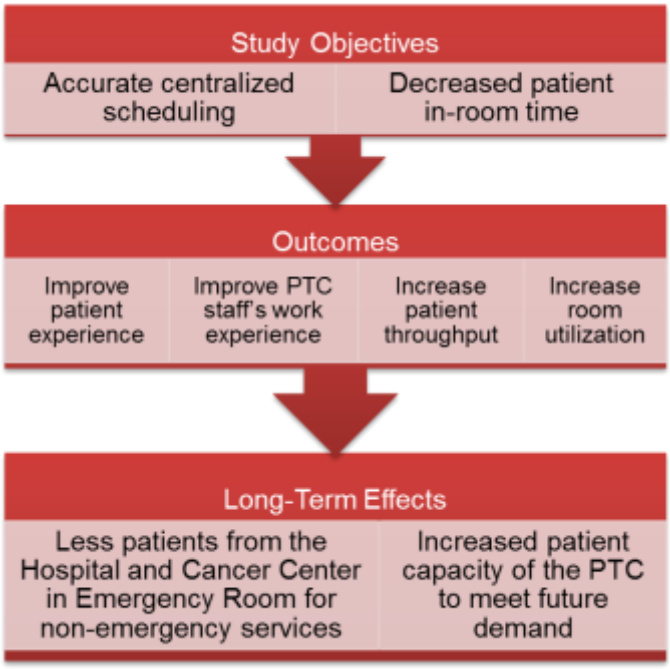


Figure 1. Long Term Effects of Project

time spent in the PTC is deemed outside of the scope of this project, along with the pain clinic process, the pharmacy medication mixing process, and the infusion process itself. The project team assumes that the actual medication mixing and administration processes

are as efficient as possible, and will not be influencing them because they are medical processes. After observing the process and talking with front-line staff, the project team was able to develop a high-level process map shown below in Figure 2 below.

Figure 2. High-Level Process Map

This high-level process map shows the flow of the process once a patient arrives. The patient checks in at the front desk to register. The registrar then brings the patient's chart back to the nursing station. This serves as a visual queue so the nurses know a patient has arrived. Once the nurse knows a patient is in the lobby and a room is ready, they go and get the patient and brings him or her back to the room. Here, the nurse will complete an assessment to make sure that the patient does not have a fever, cough, or other signs of illness. Once it is determined that the patient is healthy enough to receive his or her infusion, the nurse releases the order to the pharmacy to start mixing the medication. After the medication is delivered back to the PTC, the infusion begins. Some infusions require an obligatory observation period following the stop of the infusion. Either after the infusion stops, or after the observation period is over and there were no reactions to the medication, the patient is done being treated and leaves the room.

As a result of the define phase, a project charter was developed, which includes the project statement, scope, deliverables, outcome and process metrics, milestones, and the identification of team members' roles (Figure 3).

Project Overview

Problem Statement: In recent months the Physician Treatment Center at CDH has experienced a 21% increase in the number of infusion orders which has pushed them to expand their capacity. PTC leadership has identified an opportunity to look at their scheduling practices and current process to identify opportunities to improve efficiency.

Goal/Benefit: Develop interventions to improve scheduling and increase efficiency to reduce check-in to discharge time.

Scope: The 13 examination rooms of the PTC.

Out of Scope: Bariatric time in the PTC. Pain Clinic's process.

System Capabilities / Deliverables (1) Current and future state process map (2) Communication plan (3) Control plan (4) Implementation Plan (5) Storyboard

Resources Required: Analytics, PTC staff, PIO, Pharmacy, Blood Bank, Warrenville Cancer Center, Outpatient Registration

Key Metrics

Outcome Metric(s):

Check-in to Discharge time

Process Metric(s):

Room 11 utilization, Centralized scheduling compliance, Pharmacy phone call occurrence, Drug verification time

Milestones

Description	Date
Define	1/31/2017
Measure	2/24/2017
Analyze	3/17/2017
Improve	4/14/2017
Control	5/1/2017

Exec Sponsor: Deb O'Donnell

Sponsor(s): Kim Czaruk

Process Owner(s): Rose Mader

Improvement Leader: Mike Gegner, NIU Students

Team Members: Beverly George, Carmen Acevedo, Lisa Bowes, Elaine Rodriguez, Vu Nguyen, Patty Frey, Lauren Alvarez, Josie Ledesma

Figure 3. Project Charter

3. Measure

The project team sought to measure the current state of the process in DMAIC's Measure Phase. First, a pareto chart was utilized along with the 80-20 rule to identify the most common appointment types in the PTC (Figure 4). As a result, the project team decided to focus on improving efficiency for the following infusion types, instead of considering all 72 types that the PTC offers: Remicade, IVIG*, Invanz, Blood 2U T&C, Rituxan, Blood 1U T&C, Solumedrol, IV Hydration, Rocephin, Tysabri*, Venofer, Prolia, Blood 1U, Blood & Platelets, Blood 2U, Benlysta*, Orencia*, Krystexxa*, and Fabrazyeme*. The medications marked with an asterisk are considered "high dollar" infusions, which should not be pre-released to pharmacy because the PTC would incur a cost upwards of $50,000 if the patient cancels the appointment, does not show up, or shows up with a fever and cannot receive the infusion.

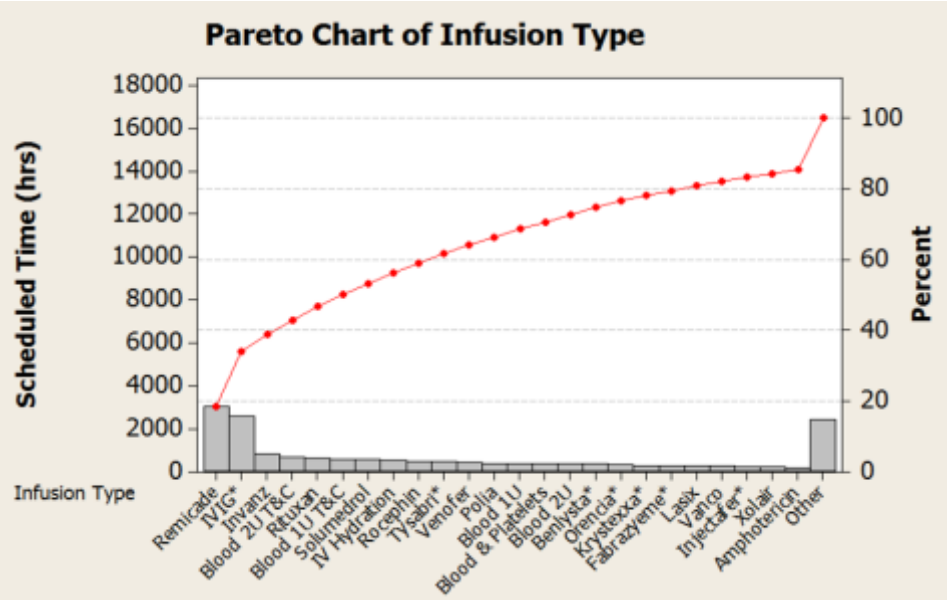


Figure 4. Pareto Chart of Infusion Type

The next step of the Measure phase is to determine baseline metrics for the top 19 infusion types. Check in to discharge time was averaged from the 2016 data in Northwestern Medicine's Epic software, to obtain the following results shown in Figure 5. It became apparent to the project team that check-in to discharge time is largely dependent on the medication type, and can range anywhere from 30 minutes to over 6 hours. Thus, schedulers in the PTC must consider appointment and infusion type when blocking off room time.

An important aspect of the Measure phase is to quantify the voice of the customer (VOC). At Northwestern Medicine, patient satisfaction is held paramount. Thus, when the project team heard that patients were complaining of long wait times for medication, a time study was conducted to investigate the issue further. PTC nurses agreed to fill out the following time sheet form (Figure 6) for 3 weeks, resulting in the collection of 132 data points. This data was used to determine the amount of time that patients wait for pharmacy to deliver medication, because this timestamp did not exist in the PTC's Epic database.

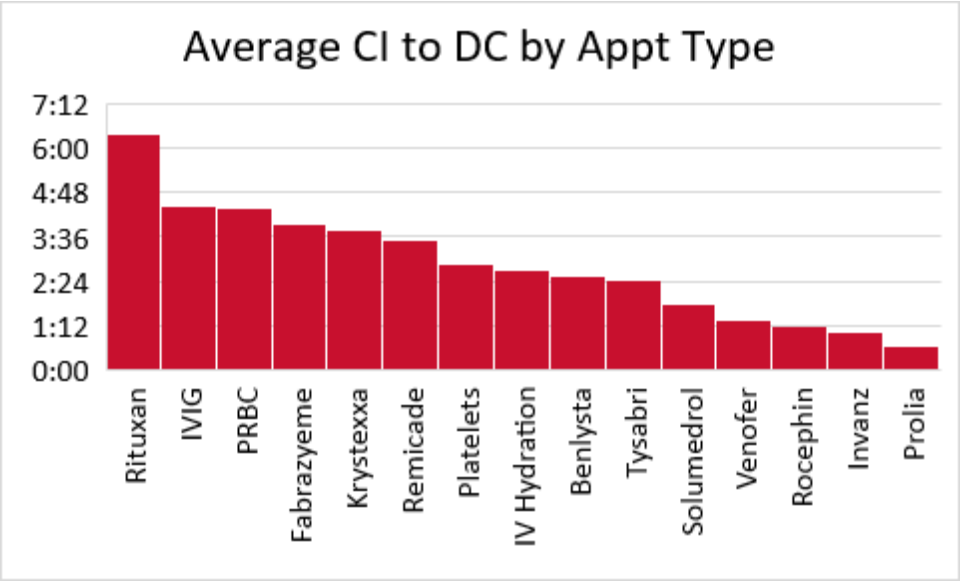
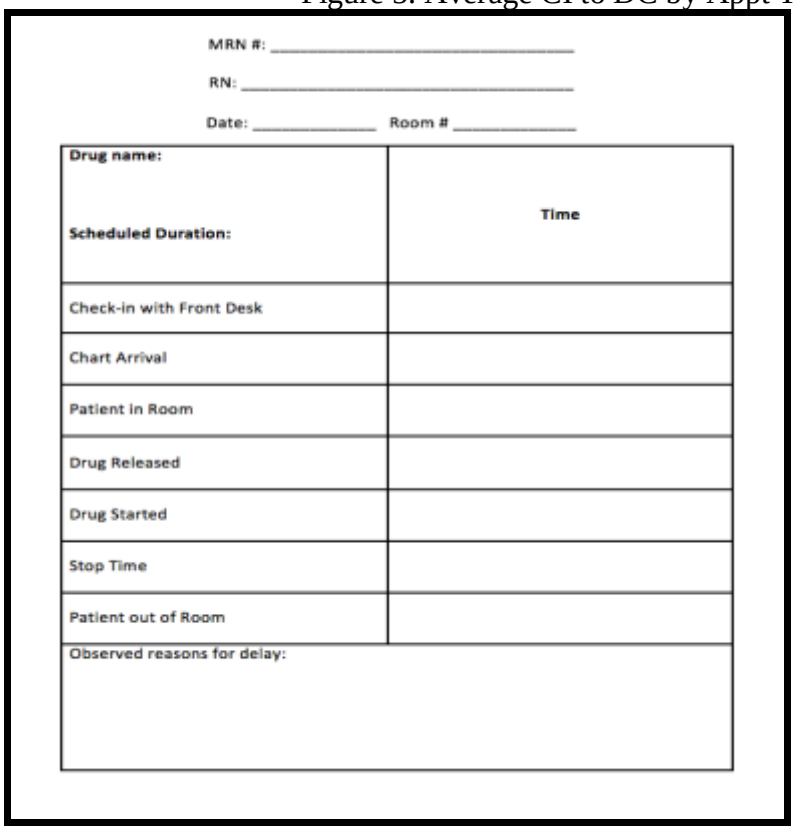


Figure 5. Average CI to DC by Appt Type



MRN #: _____

RN: _____

Date: _____ Room # _____

Drug name: **Scheduled Duration:**	**Time**
Check-in with Front Desk	
Chart Arrival	
Patient in Room	
Drug Released	
Drug Started	
Stop Time	
Patient out of Room	
Observed reasons for delay:	

Figure 6. PTC Time Study Sheet

As a result of the time study, the project team found that the voice of the customer was absolutely correct. Patients were found to be waiting an average of 28 minutes for their medication to arrive. This delay caused patients to occupy the room while watching tv and eating, which are considered to be non-value added activities. Patients who receive

infusions in the PTC often suffer from cancer or severe arthritis, so the delay was not only wasteful, but painful to the patient. The results of the time study are shown in Figures 7 and 8 below. The project team concluded that such large and frequent pharmacy delays are unacceptable, so this issue was marked for further analysis in the DMAIC Analyze phase.

Figure 7. High-Level Process Map

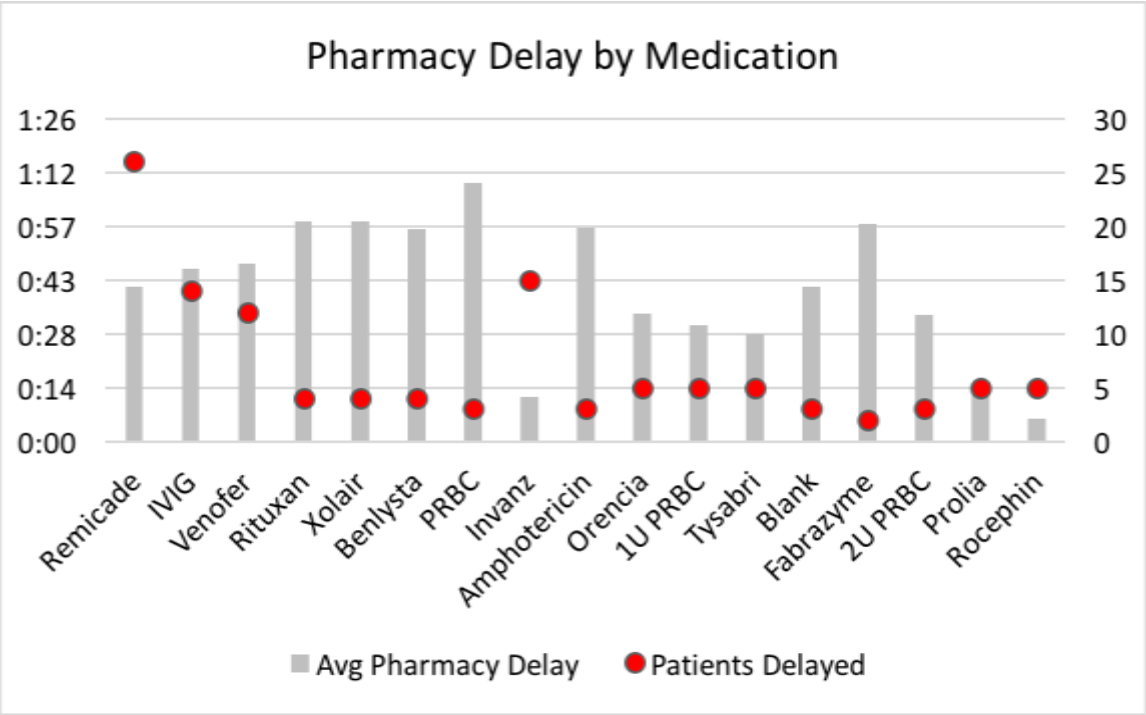


Figure 8. Pharmacy Delay by Medication

The project team also holds in high esteem the VOC of the PTC staff. Schedulers complained that there are not enough rooms to schedule patients in. However, this complaint was deemed groundless. Upon further examination of the Epic data for room utilization in 2016, all of the rooms were found to be below capacity (Figure 9). In fact, the measurements showed that the PTC was using the Pain Clinic's room 7 more than their own room 11. The project team deemed this subject an area of concern, for further investigation in the Analyze phase.

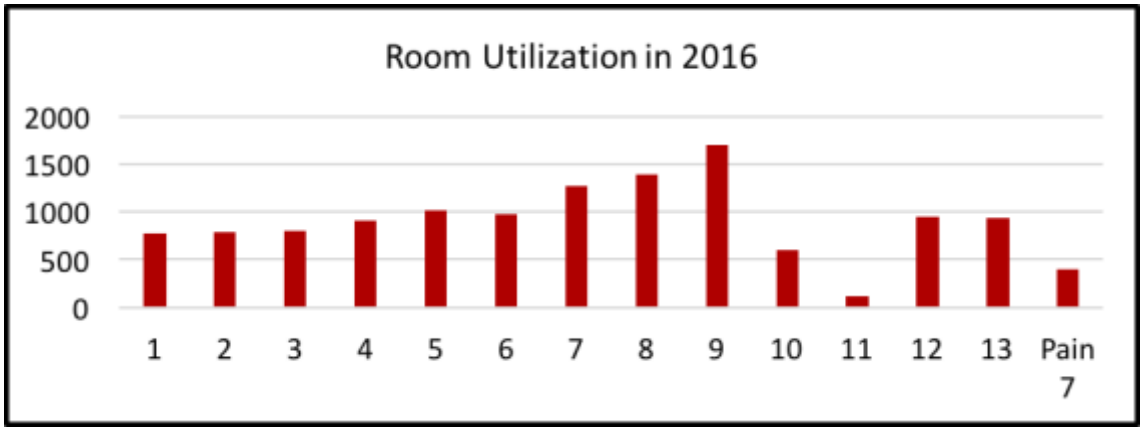


Figure 9. Room Utilization in 2016

Lastly, the project team heard the VOC that nurses are feeling strained in the morning and being sent home early in the afternoon. Measurement of the average number of patients in the PTC by hour verses the nurse capacity (Figure 10) demonstrated that the VOC was correct. The project team also heard the VOC that the schedulers feel that they have little control over the schedule; namely they cannot predict how many same day add-on appointments will occur. Upon further investigation, the project team discovered that schedulers were fixing appointments early in the morning for fear of not having enough capacity to meet add-on demand in the afternoon. However, the average add-on data per hour from 2016 did not warrant such a front-loaded scheduling practice (Figure 10).

4. Analyze

After the project team established baseline metrics by analyzing the Epic data from 2016 as well as listening to the Voice of the Customer (VOC), the project team moved forward to further analyze the problems and identify their possible causes. The project team developed a time value map using the time study data to determine the value added (VA) required non-value added (RNVA) and non-value added (NVA) time that is being spent in the PTC (Figure 11).

Figure 11 clearly shows that there is massive amount of NVA time being spent waiting for the pharmacy to deliver the medication. This immediately became one of the main focuses for the project team as it was apparent that it something had to be changed

and improved. The project team analyzed time study results to determine what drugs were causing the most delays (Table 1).

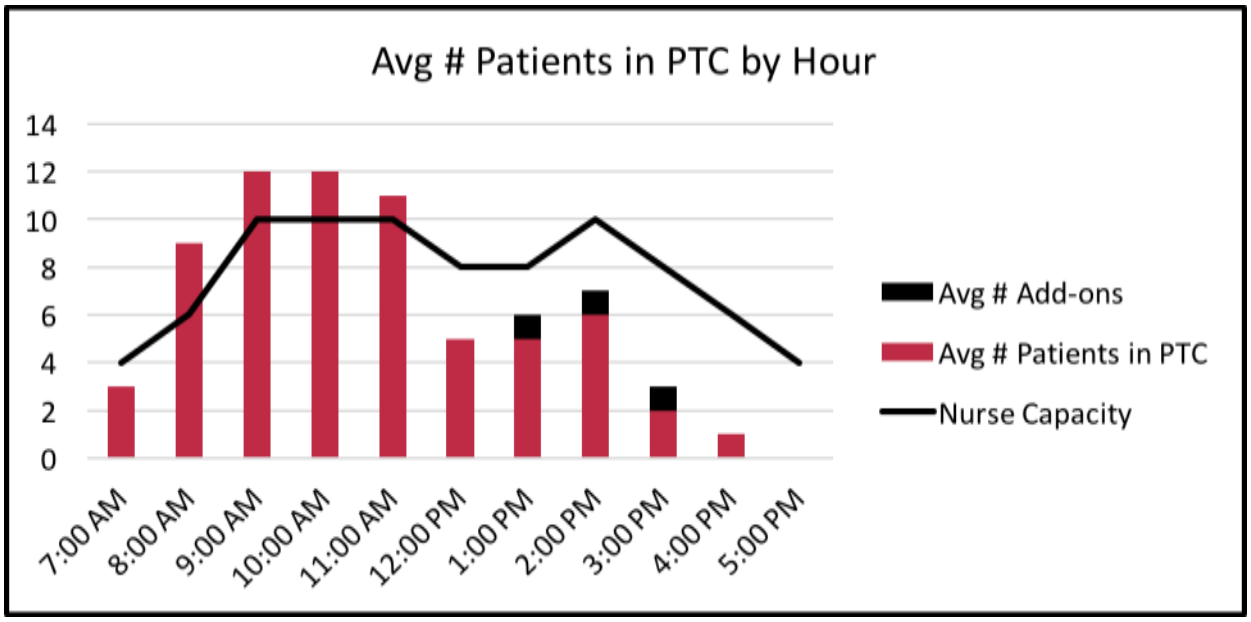


Figure 10. Avg # Patients in PTC by Hour

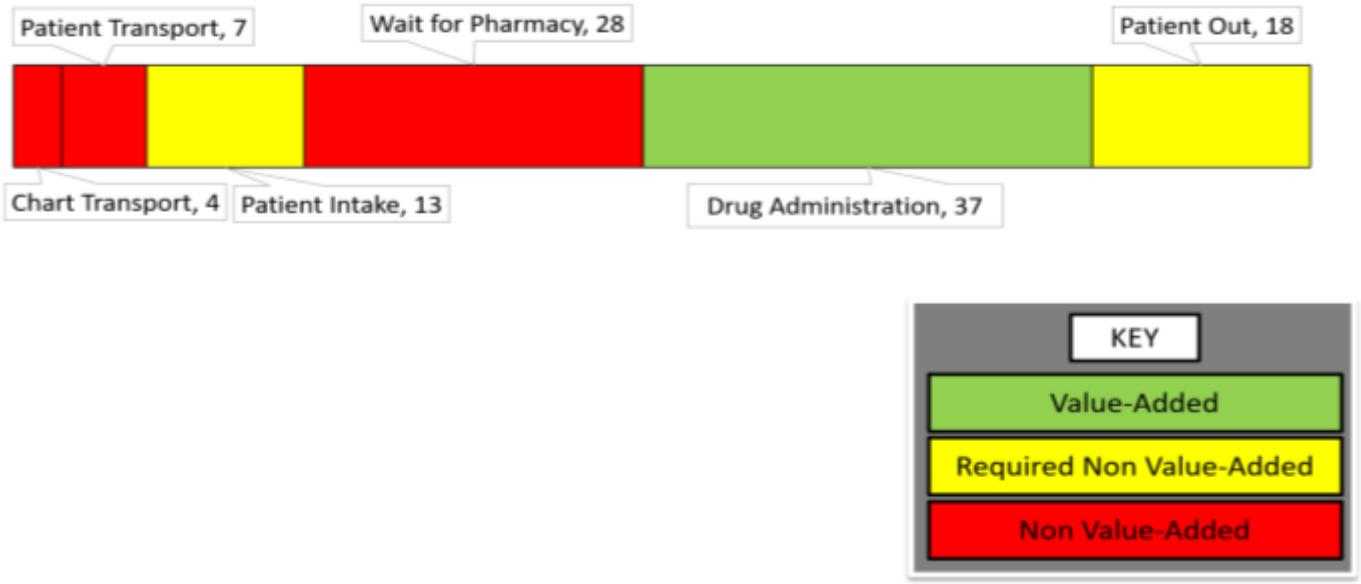


Figure 11. Time Value Map

Table 3. Pharmacy Time Study Results

Medication	Patients Delayed	Avg Pharmacy Delay
Remicade	26	0:41
IVIG	14	0:46
Invanz and Vanco	3	3:11
Venofer	12	0:47
Rituxan	4	0:59
Xolair	4	0:59
Benlysta	4	0:56
PRBC	3	1:09
Invanz	15	0:11

The team identified several drugs with average pharmacy delays of at least 40 minutes, and determined that a meeting with the pharmacy director and a pharmacist was necessary. The meeting revealed several issues, but also revealed several opportunities for improvement. There was a delay in transport between the two departments, causing finished medications to wait up to 20 minutes before the pharmacist had an opportunity to walk the medications to the PTC. The pharmacist also said that the PTC nurses were causing delays in the mixing process with frequent calls to the pharmacy, asking if the medication is ready. Multiple calls also cause miscommunications due to different people answering the phone in either department. It was also revealed that the PTC is also a lower priority for medication than other areas within the hospital such as the Emergency Department. The final source of delay the meeting revealed was a slow pre-medication release, which are imperative for the infusion process to begin.

After the project team identified the problems present in the pharmacy, they moved forward to analyze the problems concerning room utilization. The team hosted a meeting with PTC staff and administration to identify the causes of underutilization. The meeting revealed multiple causes of underutilization, particularly in the PTC's room 11 (Figure 12). The PTC staff feared confidentiality violations if room 11 were to be used, due to the fact there is a bariatrics desk directly outside of room 11. The team also

believed that room 11 did not have the proper equipment for the PTC to perform its necessary work. Lastly, the team believed that there was bariatrics equipment present in room 11 that would inhibit the daily work of the PTC staff.

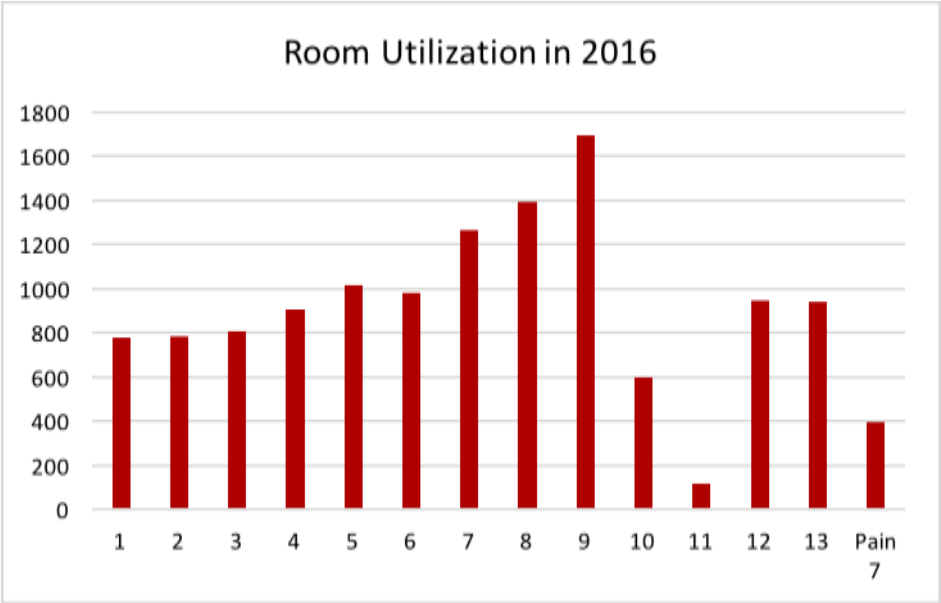


Figure 12. Room Utilization in 2016

The next area the project team felt that there were opportunities for analysis and improvement was the PTC's scheduling process. The project team facilitated a meeting with PTC staff as well as administration to determine causes of the problems currently present within the scheduling procedure. The PTC staff identified multiple reasons for poor scheduling in the meeting—the first being that the current scheduling process was completely decentralized. The PTC's scheduling practice was based off patient preference, which led to a frontloaded schedule (Figure 12). Patients were regularly being scheduled in the morning despite the fact that the PTC was already at capacity during that time frame. The schedule also became frontloaded due to the PTC staff's fear of add-ons in the afternoon. However, the presence of add-ons did not bring the PTC to capacity, as shown in Figure 13 below. The nurses were underutilized at the end of the day and were being sent home early.

The final source of poor scheduling the project team was able identify was that the PTC's current scheduling manual was inaccurate in its scheduled durations (Table 2). Remicade and Invanz were being grossly overscheduled. On average, Remicade was being over scheduled by 30 minutes and Invanz by 14 minutes. This led to a lot of wasted

time in the schedule that could be used scheduling other appointments and improving workflow in the PTC.

Lastly, the project team identified opportunities for improvement in the administration of add-ons and the delays that were present in their delivery. The project team facilitated a meeting between the PTC staff and the Warrenville Cancer Center, one of the main sources of add-ons for the PTC. It was revealed through the meeting that there were incorrect and incomplete fax forms coming from the Cancer Center. It was also revealed that patients were stopping for lunch and other various reasons on their way to the PTC from the Cancer Center. This led to patients being late for their appointments and creating unnecessary delays for the PTC. The team then developed a fishbone diagram (Figure 14) to summarize and illustrate the root causes of the long check-in to discharge time that was present within the PTC.

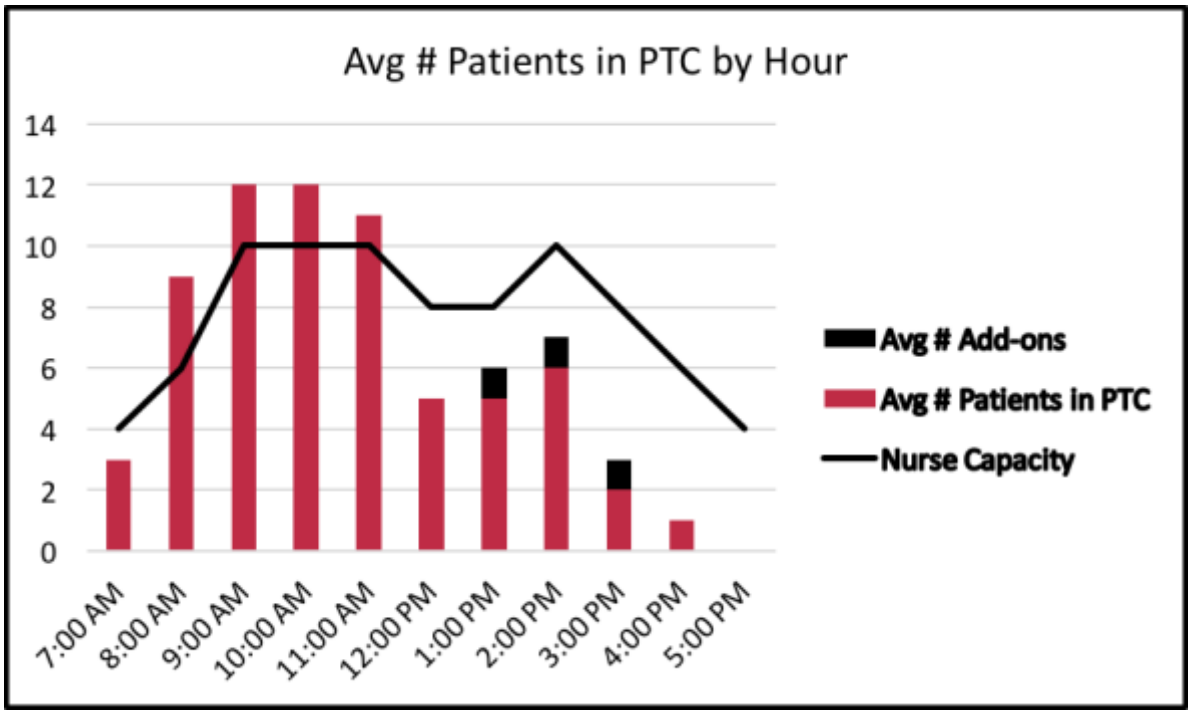


Figure 13. Avg # Patients in PTC by Hour

Table 4. Medication Over/Under Scheduling

Medication	Count Undertime	Average Undertime	Count Overtime	Average Overtime

Remicade	20	0:30	4	1:02
Invanz	15	0:14	2	0:20
IVIG	3	1:01	4	2:18
Prolia	4	0:33		
Tysabri	5	0:22		

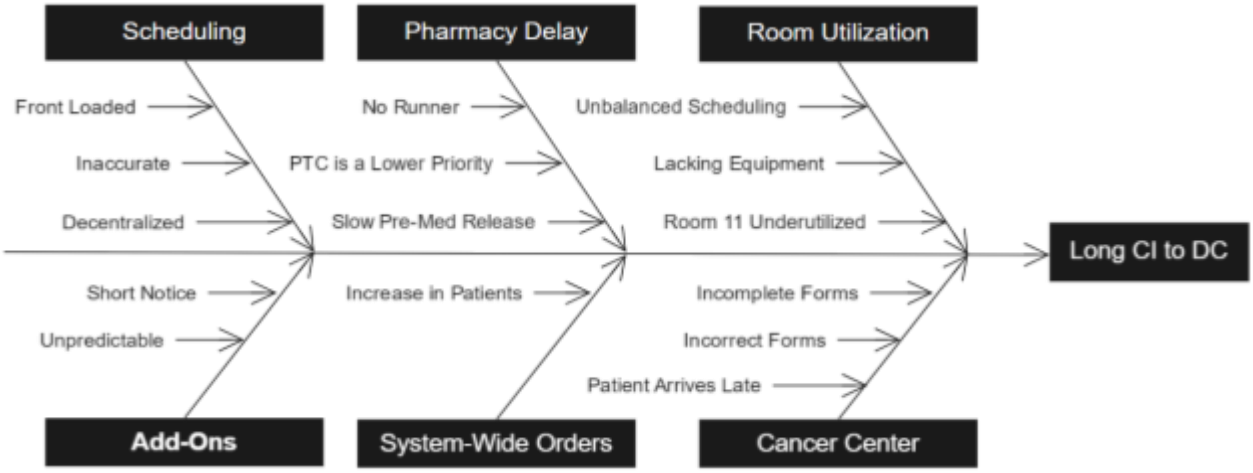


Figure 14. Fishbone Diagram

It was apparent that poor scheduling, pharmacy delays, room utilization, add-ons, system wide orders, and delays from the Cancer Center were all feeding into the long check-in to discharge time that the PTC was experiencing.

5. Improve

The project team took a two-pronged approach to developing improvements: minimizing the nonvalue-added time the patient spends in the room and developing an accurate centralized scheduling procedure. The project team facilitated several meetings in order to develop feasible improvements. There was a meeting between the PTC and the pharmacy, the PTC scheduling and administration, and the PTC and the Warrenville Cancer Center. The project team worked with frontline staff in order to develop the following improvements to ensure that they were realistic and would actually be implemented.

The time study revealed a large delay in the times it was taking to receive the mixed medications for the infusions from the pharmacy. This pharmacy delay varied between medications, and the patient would be sitting in the room the entire time of this delay. Once the PTC staff and pharmacy staff got into a room together, the project team was able to determine two main reasons for delay. The pharmacists said that the nurses from the PTC were making several phone calls throughout the shift to several different pharmacists to ask if the medication was almost ready. This caused confusion and miscommunications. Additionally, every time the pharmacist had to answer the phone, he or she had to stop what they were doing, and this was also causing additional delays. To combat this issue, the project team suggested designating phone lines in both the PTC and in the pharmacy. Now, one nurse is responsible for contacting one pharmacist throughout the shift. This streamlines communication, reduces mistakes, and limits unnecessary delays.

Another reason for the pharmacy delay was that sometimes the pharmacists were too busy mixing other medications to deliver the finished medications to the PTC. Sometimes the finished medication would be waiting 15-20 minutes to be delivered. To combat this issue, the charge nurse of the PTC and the lead pharmacist will have a daily huddle phone call in the morning. Here, they will discuss the overview of the day and give each other an idea of what to expect. If the pharmacy has a busy day ahead of them, the PTC will designate a runner to go and pick up the medications from the pharmacy as soon as they are ready. This way, the pharmacist will not be wasting their time walking to and from the PTC several times a day. The pharmacy also assured the PTC that they will verify medications in a timely manner. This reduces delays for both medications and pre-medications, some of which are stored in the PTC already.

Also, looking for ways to reduce the delay with add-on blood transfusions coming from the Warrenville Cancer Center, the project team facilitated another meeting. This revealed three main reasons for delays. First, it was discovered that patients were stopping for various reasons on their way from the Cancer Center to the PTC. To improve this, the nurses at the Cancer Center are going to educate the patients on the resources the PTC has for them. They will tell the patients not to stop and have lunch because food can

be provided to them once they arrive at the PTC. There is also TV in every infusion room of the PTC, and the nurses will remind them that it is a strict appointment time, so the patient must arrive on time as to reduce their own wait.

Secondly, it was determined that the blood bank must sometimes search for irradiated blood for some of these patients. This can take up to two hours to complete. To reduce this wait for the patient, the PTC will not call the blood bank to inform them that there is a patient in need of irradiated blood on their way over to the PTC. This way, the blood bank will be able to start the search for the special product before the patient even walks through the doors of Central DuPage Hospital. This will drastically cut their wait time. Lastly, it was brought to attention that the fax order forms for same-day blood transfusions were occasionally improperly filled out. This would cause long delays for the PTC nurses because they would have to make multiple phone calls to straighten these mistakes out. Now, the PTC will enter a Northwestern Event Tracking system (NETs) report to track who is making the errors while filling out the fax orders. There can then be education to teach the physicians making the mistakes on the order forms how to properly fill them out. In addition to these improvements, the Performance Improvement Office is opening up an additional project between the PTC and the Warrenville Cancer Center to try to administer the blood transfusions at the Warrenville Caner Center. The patients receiving the same-day blood transfusions are very sick. They are typically cancer patients whose blood counts are too low to even receive their chemo. Northwestern Medicine strives to put the patient first, and this would significantly improve the patient experience.

The project team also aimed to improve the scheduling procedures. It was important to ensure that the appointments were being scheduled for an accurate time. The time study revealed that two medications were being grossly overscheduled for. For 20 patients receiving Remicade during the three week period the time study was being conducted were overscheduled by an average of 30 minutes. 15 patients receiving Invanz were overscheduled by an average of 14 minutes. The suggested appointment time for these medications were adjusted in the scheduling guide. Now, the appointment made for these medications will more accurately represent the actual appointment time. Another

issue that the PTC was experienced was unbalanced scheduling. The schedulers had little control over when patients were coming in. They were also scared of how many possible add-on appointments could come in the afternoon. Because of this, the PTC had more appointments in the morning than they could handle, causing the nurses to feel overworked. However, the afternoons were mostly empty, and nurses were being sent home due to lack of demand. To combat this issue, the project team came up with a list of medications that should only be scheduled in the afternoons and a list of medications that should only be scheduled after 2 pm (Table 3). All of these appointments are either a half hour or an hour long, and there is no fear that they would not be able to finish them before the department closes.

In order to confirm that this suggestion would help the nurses feel the day is more evenly balanced, the project team rescheduled a year's worth of appointments according to the new guidelines to come up with an average day. This comparison can be seen below in Figure 15.

Table 5. Afternoon Appointment Types

Appointments to schedule after 12pm	**Appointments to schedule after 2pm**	
Cefazolin	Avonex	Phlebotomy
Invanz	Bicillin	PICC Line
Invega	CADD Pumps	Procrit
Orencia	Dalbavancin	Prolia
Rabies	Granix	Resperidal
Rhogam	Injectafer	Venofer
Sandostatin	Neulasta	Vivitrol

Solumedrol	Neupogen	Xolair

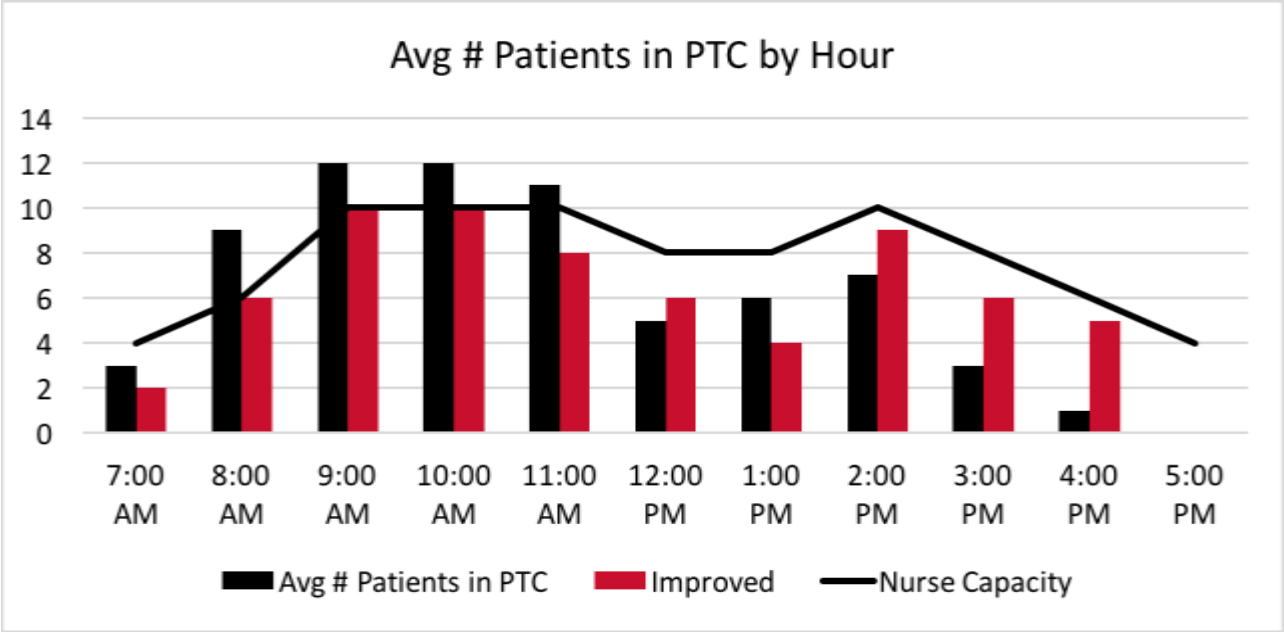


Figure 15. Avg # Patients in PTC by Hour-Improved

Here, the black bars represent the current scheduling practices, and the red bars represent the new and improved scheduling practices. The nurses are feeling less overworked in the mornings, and now the rooms are not sitting empty in the afternoon. The demand does not exceed nursing capacity, and there is even still a small amount of room available for unexpected add-on appointments or variation.

Lastly, the project team wanted to update the standard work for scheduling. Previously, there was little to no structure of how to schedule a patient's next appointment. Since most of the patients are reoccurring and come in on a regular basis, it was largely driven by patient request. The updated standard centralized procedure for scheduling a patient can be seen in Figure 16.

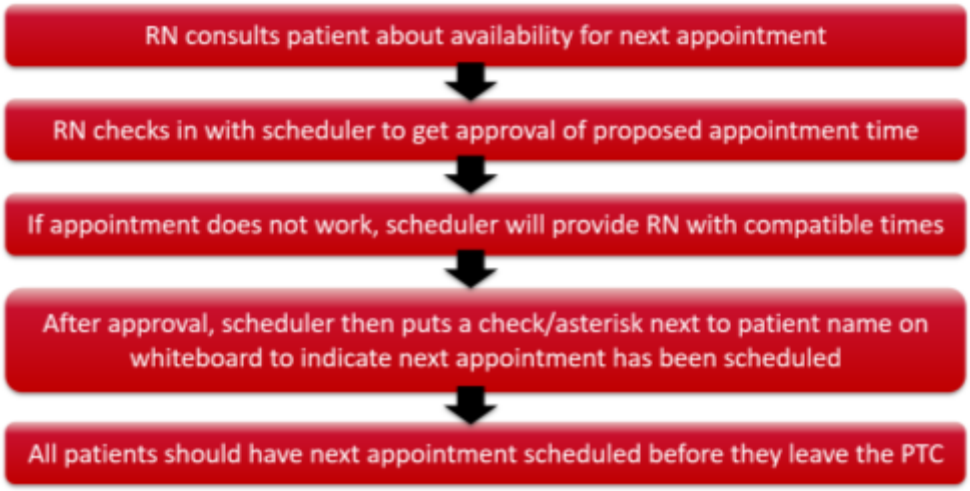


Figure 16. Improved Scheduling Standard Work

The new scheduling procedure centralizes control of when the appointments are made with the scheduler. Previously, nurses were scheduling patients without consulting the current calendar of available appointment times. Now, there is less potential for double scheduling a room or needing to call a patient to reschedule their appointment. This new updated standard work also ensures the patient has scheduled his or her next appointment before they leave their current appointment. This is reinforced by the visual approval from the scheduler by the check mark by the patient's name on the whiteboard.

Combined, these efforts aim to decrease the nonvalue-added time the patient spends in the room and update the scheduling procedure to ensure times are accurate and scheduling is centralized. Together, these efforts will decrease the check-in to discharge time the patient experiences. These improvements are realistic approaches to the problems at hand, and are actually implemented. The PTC will run more efficiently once these new procedures are being followed.

6. Control

Of the five DMAIC cycle steps, the Control phase is arguably the most critical to the long-term success of any project. The project team took special care to ensure that steps from the Improve phase will be sustained over the weeks and months to come. The

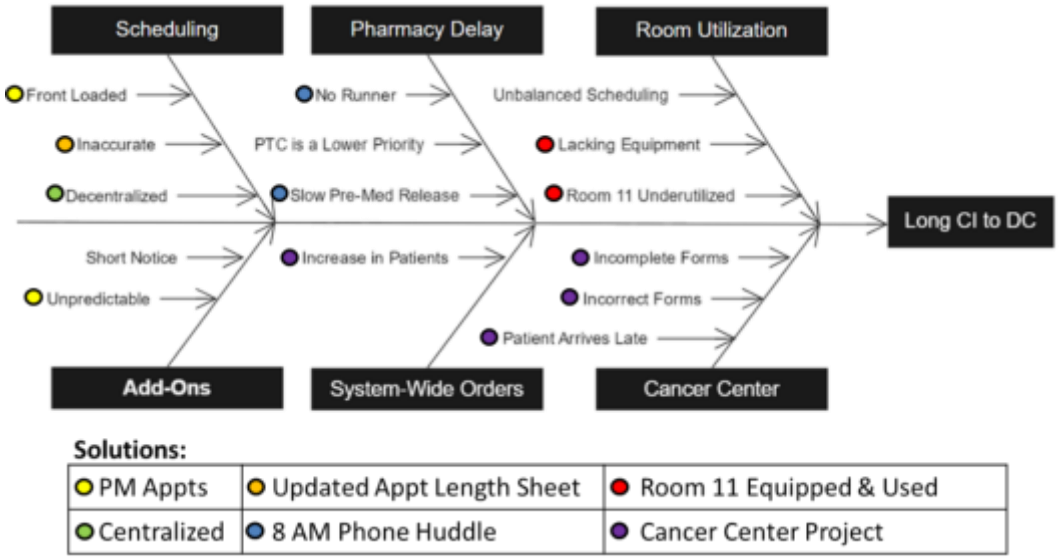
four main improvements that directly reduce Check-in to Discharge time were included in the PTC Control Plan (Table 4). The following control plan was initiated and agreed upon during the closing meeting of this project. The PTC staff emphatically agreed that the implementation of this plan is critical, and the accountable leaders mentioned in the "who" column of Table 4 agreed to ask the corresponding indicating question according to the frequency described. If the criteria has not been met, the corresponding corrective action will be taken to ensure the continued success of this project.

Table 6. Control Plan

Process Step	CTQ	Indicating Question	Measurement Method	Frequency	Who	Where	Corrective Action
Room 11 is fully equipped and being utilized	x	Has room 11 been used today?	Visual	Monthly	Process Owner	Epic	HUC, CSC, and Rose review schedule and identify appointment types to schedule in room 11
Central scheduling enforced through whiteboard accountability	x	Is there a check mark next to each patient's name who needs a next appointment?	Visual	Daily	HUC	White Board	Follow up with nurses who weren't compliant. Re-education of new processes and benefits
Daily 5 minute phone huddles between Pharmacy and the PTC to determine if medication pick-up will be necessary	x	Did a phone call take place today?	Experience	Daily	Charge Nurse	Daily Log Sheet	Rose will contact pharmacy director to develop plan to reinstate the process
Pharmacy now verifies pre-medication orders in a timely manner	x	Is pharmacy verifying drug within the promised time?	Visual	Monthly	Process Owner	EDW Report	Discuss any delays in verification with pharmacy in daily huddle

7. Recommendations/Conclusions

In conclusion, the project team identified 15 contributing factors to a long check-in to discharge time, and offered solutions for 12 of them (Figure 17). Two of the factors that were not addressed, "PTC is a lower priority" and "short notice" were deemed unavoidable. Prioritization of departments in the Pharmacy, and the notice time of add-ons from other appointments were beyond the scope and control of this project. The "unbalanced scheduling" factor would be a great area for further study. However, the project team decided that the issue was not pertinent to the time frame of this project, because room utilization is far below capacity and thus, rooms are not a constraint.



Solutions:

PM Appts	Updated Appt Length Sheet	Room 11 Equipped & Used
Centralized	8 AM Phone Huddle	Cancer Center Project

Figure 17. Fishbone Diagram with Corresponding Solutions

The project team conducted an economic analysis to find the financial impact of the project. Before this study, the PTC was considering the addition of one full time nurse and the construction of another room, to eliminate the apparent staff and room constraints. However, the project team was able to implement improvements that removed both constraints. Thus, this project saved the PTC the cost of one full time employee, who would make $71,138 at Northwestern Medicine, and the typical construction cost of a medical room, in addition to overhead and equipment costs of a new room (Glassdoor, 2017). Additionally, the project is predicted to make the PTC an additional $591,000 over the next year. This is because the PTC administration feel so confident in the changes implemented, that they comfortably budgeted a capacity increase of 3,000 units of service over the next year.

The success of this project can be largely attributed to the willingness and buy-in of PTC staff. Every analysis and suggestion made by the project team was carefully considered and applied, leading to immediate results and a positive work environment. The project team is also thankful for the leadership and direction of Michael Gegner, an NIU alumnus who coordinated meetings and will wrap up the last elements of the control phase with the PTC. Special thanks also go out to John Parker, Director of the Performance Improvement Office and Dr. Damodaran, Dean of the Industrial and Systems Engineering Department, who collaborated together to form the bond between

the two organizations, that led to the opportunity for this project. Input from both of these leaders on the project team's work was also critical to its success.

Lastly, the project team made a strong effort to follow all of the six cannons of the NSPE Code of Ethics for Engineers. This was made manifest in the ethical conduction of time studies, presentation of results, and integrity demonstrated every day at Northwestern Medicine.

8. References

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